2007 RESEARCH PROBLEM STATEMENT

Problem Title: Shaking Table Testing of EQ Drains **No.:** 07.07-8

Submitted By: Kyle Rollins **Email:** rollinsk@byu.edu

Project Champion: Jim Higbee

(UDOT or FHWA employee who needs this research done, will help the Research Division lead this project, and will spearhead the implementation of the results. If the project gets prioritized at the UTRAC conference, a Champion Commitment Form will be required before funding.)

1. Briefly describe the problem to be addressed.

Although blast liquefaction studies have shown that EQ drains greatly increase the rate of drainage under field conditions, they have not prevented liquefaction. In addition, it is difficult to compare pore pressure development during blasting and an earthquake. At present, no direct field or laboratory data is available to confirm whether or not the drains have the ability to limit pore pressures and resulting settlement to acceptable levels. However, shaking table tests can be conducted with a large shear box (20 ft high, 9 ft wide, 16 ft long) containing drains at SUNY-Buffalo and compared with identical testing currently underway for another funded study. Tests will be performed at progressively higher acceleration levels and durations to allow comparison of performance (pore pressure & settlement) for earthquake conditions. Partner organizations (Caltrans and Nilex, Inc.) are prepared to provide $80,000 in matching funding if UDOT will serve as lead agency in a pooled-fund study.

2. Strategic Goal: ☐ Preservation ☒ Operation ☐ Capacity ☒ Safety (check all that apply)

3A. List the research objective(s) to be accomplished:

1. Evaluate the ability of drains to prevent liquefaction as a function of acceleration and duration
2. Compare settlement of treated sand relative to untreated soil.
3. Evaluate accuracy of simple models and computer models to predict measured behavior.

3B. List the major tasks to accomplish the research objective(s): **Estimated person-hours:**

1. Prepare test specimen in laminar shear box with EQ drains.
2. Conduct shaking table tests at progressively higher accelerations measuring water pressure, acceleration, and horizontal and vertical displacement.
3. Reduce the test data and compare with previous test on untreated sand
4. Compare measured behavior with behavior computed using computer models and simplified models.
5. Compare effectiveness of EQ drains to traditional wick drains.
6. Prepare final report on effectiveness of drain technique.

4. Estimate the cost of this research study including implementation effort (use person-hours from No. 3B): $140,000 ($40,000 from UDOT and $80,000 from others in a pooled fund)

5. Indicate type of research and/or development project this is

Large: ☒ Research Project ☐ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative
☐ Other: _____

(A small project is usually less than $20,000 and shorter than 6 months)

6. Outline the proposed schedule (when do you need this done, and how will we get there):

Baseline testing without drains is to be performed at SUNY-Buffalo in Summer 2007 with NSF funding. Time for the drain testing will be available in November.

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7. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?
University acting in cooperation with UDOT Staff

8A. What deliverables would you like to receive at the end of this project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
Report defining performance of EQ drains relative to untreated sand and verification of techniques for predicting performance.

8B. Describe how this project will be implemented at UDOT.
Technology for installing EQ drains is readily available and the computer software for performing the analysis which was developed by UC-Berkeley as is available at no cost from Nilex, Inc. A workshop on the use of the software for design could be conducted at the conclusion of this study.

8C. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be.
EQ drains offer the potential to deal with liquefaction problems at 30 to 50% of the cost and time required with conventional densification techniques. Drains could also be used in combination with other improvement techniques where it might be difficult or too expensive to completely prevent liquefaction through densification. Drains are particularly attractive for marginal liquefaction problems or for locations where it might be economically difficult to justify the conventional densification procedure. Beneficiaries would be public which would obtain increase safety and continued highway capacity during earthquake events..

9. Describe the expected risks and obstacles as well as the strategies to overcome them.
If the SUNY-Buffalo testing program is delayed in summer/fall 2007 or bad weather prevents our testing, the testing program might be delayed until Spring of 2008. Prof. Thevanangam indicates that he has another small project in 2008 which could likely be paired with our tests in 2008, if necessary, to minimize the cost of putting the shear box back in place on the shaking table.

10A. List other people (UDOT and non-UDOT) who are willing to participate in the Technical Advisory Committee (TAC) for this study:

Name	Organization / Division / Region	Phone	Email
Jon Bischoff	UDOT/Geotech	801 965-4326	jonbischoff@utah.gov
Brad Price	RBG Engineering	801 374-5771	Bprice@rbgengineering.com
Bob Goughnour	Nilex, Inc.	703 771-0135	bgoughnour@potomaccrossing.net
Tom Shantz	Caltrans	916 227-7245	tom_shantz@dot.ca.gov

10B. Identify other Utah, regional, or national agencies and other groups that may have an interest in supporting this study:
Tom Shantz, Caltrans Research $30,000; Bob Goughnour, Nilex, Inc. $50,000, Oregon and Washington DOTs, .